Chapter 3
The Washington Input-Output Tables for Impact Analysis

The most common application of regional input-output tables is impact analysis. Actually, in most cases the sole reason for constructing a regional I-O table is to use it as an analytical tool for conducting economic impact analysis. The analysis measures the changes in output (i.e., production), employment, and income in all state industries as a consequence of: (1) known demand changes in the output of some particular industries in the state – the **Simple Analysis**; or (2) a new activity or industry not identified in the input-output table – the **Complex Analysis**. The complex analysis procedure presumes that the output, employment, labor income, and first-round purchases of the activity/project are known.

Two impact spreadsheet files, one using the Washington Standard Industrial Classification (SIC)-based I-O Table and the other using the North American Industry Classification System (NAICS)-based Table, are provided for downloading; each file contains two sheets used to perform the simple analysis and the complex analysis, respectively:

Impact Worksheet: SIC-Based

Impact Worksheet: NAICS-Based

The Input-Output Model For Impact Analysis

To be used as a tool for economic impact analysis, the I-O table needs to be transformed into an analytical "model". This model should be able to quantify how an external change in final demand will invoke a chain of reactions in the economy: the demand-induced increase in one industry's output will require it to raise its inputs/purchases, which then raise the demand for other industries' output and their purchases of inputs, and so on. The chained reactions are generally referred to as the "ripple effect". The inter-industry transaction or intermediate demand part of an I-O table (component 1 of Table 1-1) actually serves this purpose, and thus is used as the core of the I-O impact model.

The first step it takes to build an I-O impact analysis model is to convert the inter-industry transactions into "direct purchase coefficients". This is done by dividing each inter-industry transaction in Table 1-1 by the respective industry's total input (i.e. value of the element in the last row of the industry column). Table 3-1 contains the resulting industries' direct purchase coefficients. For example, in the manufacturing column, the value in the first cell shows the ratio of the purchases of natural resource industry inputs by manufactures to total manufacturing output; the value is .0382 (=3,114.3/81,554.0; transaction values found in Table 1-1).

Each coefficient a_{ij} can be interpreted as the proportion of industry *j*'s production input supplied by industry *i*. So the value of a_{12} implies that the manufacturing industry requires $3.8 cents of natural resource industry products from Washington establishments for every dollar of the manufacturing industry's total input.

Entries in the fourth row are labor earnings as a portion of the industry's total input payments. The fourth column contains entries showing personal consumption of industry *i*'s product as a portion of total earnings.

Table 3-1
1997 Washington State Direct Purchase Coefficients Table
(Dollars Purchased Per Dollar of Total Input)

Industry (SIC)	**Natural Resource**	**Manu-facturing**	**Trade and Services**	**Personal Consumption**
Natural resource	0.1042	0.0382	0.0019	0.0057
Manufacturing	0.0586	0.0935	0.0362	0.0429
Trade and services	0.1444	0.1123	0.2365	0.5997
Labor Earnings	0.3024	0.2242	0.3701	0.0000

The inter-industry transactions or output needed to satisfy a given level of gross output can be shown as:

$$O = A \bullet X$$

where A denotes a matrix containing the direct purchase coefficients; X is a vector consisting of the industries' gross output; and the product O is a vector containing the intermediate demand for industries' output.

An industry's total output (X) equals the sum of the intermediate demand for its output and the total final demand for its output:

$$X = O + D$$

Where D denote a vector containing total final demand (including exports) for each industry's output.

Combine the two preceding equations:

$$A \bullet X + D = X$$

Rearranging the above equation:

$$D = (I - A) \bullet X$$

Thus, $X = (I - A)^{-1} \bullet D$ and then $\Delta X = (I - A)^{-1} \bullet \Delta D$

The last equation indicates a change in total output is the product of a change in total final demand multiplied by $(I - A)^{-1}$. The inverse matrix $(I - A)^{-1}$ is generally referred to as the "*Leontif Inverse*" in input-output modeling. Table 3-2 show the inverse matrix from the 1997 three-sector aggregate I-O (SIC-based) Table. The elements in this matrix are "total requirement coefficients". For example, values in the second data column of the table show that, for a one-dollar increase in the final demand for the state's manufacturing output, local resource and trade/services industries have to raise their output by \$0.0533 and \$0.5568 dollar, respectively.

Table 3-2
1997 Washington State Inverse (Total Requirement) Coefficients Table
(Total Dollars of Input Per Dollar of Output)

	Natural Resource	Manu-facturing	Trade and Services	Personal Consumption
Natural resource	1.1277	0.0533	0.0134	0.0168
Manufacturing	0.1329	1.1516	0.1118	0.1172
Trade and services	0.7388	0.5568	1.9054	1.1708
Labor Earnings	0.6442	0.4804	0.7343	1.4647

Once an *Inverse* I-O matrix is derived, total impact of a proposed project or activity on the state economy can be estimated by multiplying this matrix by the changes in final demand caused by the respective project/activity. This computation is implemented in the impact spreadsheets. (Impact Spreadsheets: *SIC-based*, or *NAICS-based*).

Magnitudes of the estimated impact vary by the degree of model closure. The model developed by this Study produces what is generally referred to as the "type II" impact estimates. Basically the impact estimation captures the inter-industry ripple effects and earnings-induced changes in personal consumption. But the model excludes the effects on the government sector and on investment spending. Other I-O models that incorporate government and investment usually result in higher impact estimates.

Limitations on the Input-Output Impact Analysis

The input-output model for impact analysis inherits all the properties of an input-output table: the input-output table represents a static depiction of the economy at a point in time; the linear, fixed-proportion production function implied in an input-output table dictates constant return to production scale, and no substitution between intermediate goods, capital, and labor inputs; and the additivity (i.e. total output is the sum of individual output) among industrial sectors assumes no external economies or diseconomies. All these properties, or assumptions, impose restrictions on the uses of input-output model for impact analysis:

(1) The model will better approximate the economy the closer to the year for which the model is constructed. In other words, the farther away from the model year, the less accurate the impact estimation would be.

(2) The model assumes a fixed employment-to-output ratio at industry level and uses these ratios to calculate employment impact. Moving away from the model year, growth in labor productivity would increasingly reduce the validity of using these fixed ratios to estimate employment impact.

(3) The model assumes local supply is perfectly elastic, meaning there is no capacity problem. For this assumption to be upheld, the projects or activities to be assessed need to be small or marginal relative to the economy's production input system. Otherwise, the projects will disrupt the relative equilibrium prices, leading to significant factor or import substitutions.

(4) I-O analysis estimates total impact from an external change in final demand. Projects that bring into the state investment money or other spending from outside the state result in direct external changes in the final demand, using an I-O model to estimate total economic impact caused by these projects is straightforward. When the project's funding is not external, such as a local government investment activity funded by tax dollars, the impact needs to be evaluated on both the activity (positive effect) and on the corresponding funding (taxes' negative effect on consumption) to estimate the "net" impact.